

# **Neighborhoods and Crime Rates: A Redefinition of Ecology**

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# **Neighborhoods and Crime Rates: A Redefinition of Ecology**

## **ABSTRACT**

Several research studies have identified that the social and physical characteristics of neighborhoods are related to crime. However, researchers are consistently challenged by trying to define and develop physical ecology, including land-use typologies, and by defining appropriate neighborhood sizes. The current research project combines unique methodology while attempting to define and identify relevant land-use patterns that influence property and violent crime rates in a large urban city. Results indicate that mixed land-use is related to crime, and that these effects diminish when the definitions of neighborhood size is increased.

## **INTRODUCTION**

Since the early 1900's, researchers have been fascinated by how and why neighborhoods affected their residents and their social dynamics (Park, 1916; Park and Burgess, 1925). Shaw (1929) and Shaw and McKay's (1942) social disorganization theory introduced the importance of both social dynamics and physical ecology in the study of community social organization and delinquency. Drawing upon these theoretical roots, many researchers have continued to study how and why neighborhoods affect the social dynamics and characteristics--including crime rates (e.g., Cohen and Felson, 1979; Stark, 1987; Sampson, 1985; 1987; Sherman, Gartin, and Buerger, 1989). Recent criminological research has focused the impact of social characteristics on the patterns of crime and victimization (Sampson and Groves, 1989; Sampson, 1999; Taylor, 1997; Morenoff and Sampson, 1997).

While some attention has been given to the physical ecology, or layout/composition, of neighborhoods, social scientists have primarily relied on the measures and effects of neighborhood social ecological context. Indeed, criminological theorists have given primacy to

social characteristics. These characteristics have included economic/poverty rates, racial heterogeneity, age composition, and gender composition, amongst others. The importance of individual characteristics and other social ecological phenomena has been demonstrated when studying the rates of crime and deviance, however differences in a neighborhood's physical characteristics, such as land-use patterns, are also important when studying neighborhood crime rates. Several researchers have discussed the importance of physical ecology when studying various social phenomenon (Shaw and McKay, 1942; Newman, 1972; Taylor and Gottfredson, 1986; Stark, 1987; Raudenbush and Sampson, 1999), yet these same researchers have faced many challenges and difficulties when attempting to measure and define physical characteristics of neighborhoods.

Raudenbush and Sampson (1999) suggested one solution to determining the differences in neighborhood physical ecology. These researchers used direct observation to collect evidence on the physical conditions of a neighborhood. This process was most likely both time-consuming and costly. Many researchers have neither the manpower nor the financial means to perform such a study, and have tried other methods. For example, prior to this work by Raudenbush and Sampson, Felson (1987) examined the frequencies of property crimes reported to police agencies across the state of Illinois by the type of physical location at which the crime occurred. Researchers have also examined the relationships between certain types of places, such as public housing units or public transit stations, and the occurrence of crime at or near these places to see if there is a distance decay effect (Fagan and Davies, 2000; Block and Block, 2000). Yet other researchers, studying victimization patterns in Seattle, have relied upon survey measures of physical ecology (e.g., Rountree, Land, and Miethe, 1994). Specifically, this series of papers has asked survey respondents about whether or not particular land-uses (e.g., parks, bus

stops, schools, etc.) could be found within 3-4 blocks of their homes. Each of these methods has associated strengths, but each also has its own limitations.

Related to the difficulties associated with measuring physical ecology, the predominance of social characteristics in crime theory and research may also be symptomatic of the convenience of finding testable data. While social characteristics of neighborhoods are relatively accessible through census and survey measures, measures of physical ecology are much more difficult to tap. The physical ecology of a neighborhood is the composite of many structural characteristics. For example, does the housing market consist of single-family residences or high-rise multi-family dwellings? Is there a park in the neighborhood? Is commerce or industry represented in the neighborhood—bars, shopping areas, factories? As noted above, traditional criminological studies have focused on the effects of social activity patterns on crime and victimization rates. However, some researchers have suggested that neighborhoods and places could be criminogenic in and of themselves (Stark, 1987; Sherman et al., 1989; Raudenbush and Sampson, 1999). That is, theorists have discussed and studies have examined whether the physical characteristics in neighborhoods increase crime. For example, Stark proposed that neighborhoods that share their residential area with industry and commerce have higher crime rates.

Criminologists have are also faced with many challenges when defining appropriate units of analysis, or “neighborhood” sizes. Because this issues is complicated by the availability of data at each level of aggregation, researchers traditionally relied upon large census-defined geographic areas, such as tracts, as their definitions of neighborhoods, even though these areas can hold up to 8,000 residents within their boundaries. However, newer and less financially draining data collection techniques and resources have become available. Increasingly, police

departments publish crime data at the 100-block street address level. Researchers can aggregate this information to fit their own definition of neighborhood, rather than a previously assigned area. City governments can provide tax parcel data that describes land-use at the level of each separate land parcel, such as for each housing unit or building (Smith, Frazee, and Davison, 2000). This information can also be aggregated to a larger definition of neighborhood. With these new formats, researchers have the opportunity to examine the effects of neighborhood on crime rates.

The current research paper extends prior ecological studies that focused only on how neighborhood-level social characteristics relate to crime rates. This paper examines both the definition of physical ecology and the definition of neighborhood size. First, this research measures the effects of neighborhood-level social ecology on crime rates. Second, using data that identifies the current land-use of individual land parcels, this research explores how the presence of various patterns of physical ecology affects crime rates. Does the neighborhood's degree of land-use heterogeneity, or the presence of residential, industrial, and commercial land uses impact crime rates? Third, this research measures whether social and physical ecological patterns interact to influence crime rates. And finally, this research examines whether or not the level of aggregation influences the significance of results. That is, do the effects of structure wash out when block-groups are aggregated up to the census-tract level?

To accomplish these goals, this research constructs a unique data set incorporating three types of information to examine the context of crime. Preliminary sources of data include census data, Bexar County tax parcel data, and Violent Crime and Burglary rates from the San Antonio Police Department. This unique integration of data is only possible in a *Geographical Information System (GIS)* database. Through GIS, researchers can enhance the value of the three

independent data sets by combining them and they can also use GIS technologies to change their definition of neighborhood to progressively larger or smaller geographic areas. The current research project will apply these techniques to examine neighborhood effects on crime rates at both the blockgroup and census tract levels.

## **THEORHETICAL PERSPECTIVES**

To examine the research questions, three bodies of work examine the physical ecology and social activity levels of areas. First, social disorganization theory helps explain the effects of aggregate social characteristics, such as concentrated disadvantage, on neighborhood deviance levels (Shaw and McKay, 1942; Sampson, 1985; 1987; 1999; Sampson and Groves, 1989). Second, routine activity theory was created for and continues to explain the effects of the social activity patterns, through the movement of individuals in an area, on neighborhood conditions such as deviance (Cohen and Felson, 1979; Felson, 1979). Third, Stark's (1987) theory of deviant places, suggests that the types of land use as well as the combination of different land-use patterns may influence the levels of deviance in a neighborhood. Each of these three areas of literature is introduced below and discussed in terms of its relevance to crime rates.

Social disorganization theory arose from the early works of Shaw (1929) and Shaw and McKay (1942). They argued that low economic status, ethnic heterogeneity, and residential mobility lead to the disruption of a community's social organization and community solidarity, and found that variations in social organization correlated with delinquency and crime. In the past twenty years, researchers have expanded the knowledge base on the contextual effects of social disorganization in neighborhoods and communities. Much of the work in the early 1980's on social disorganization theory focused on neighborhood change and community disorder in the context of delinquency rates. Findings in this area have suggested that social integration factors

(e.g., family structure and mobility) and opportunity factors (i.e., density) affect individual levels of criminal victimization (Sampson, 1985) and that persistently high crime rates in black neighborhoods were linked to community-level unemployment, poor economic conditions, and family disruption (Sampson, 1987). Finally, researchers reported that the process of neighborhood change (e.g., becoming underclass or gentrified) was important to understanding changing rates of crime (Taylor and Covington, 1988). However, as noted above, a majority of this work has used compositional effects, or types of people explanations, to measure neighborhood attributes. The original social disorganization theorists were trying to get away from these types of explanations and turn to a measure of neighborhood context.

Routine activities theorists have also examined ecological effects. The pioneers of this theory, Cohen and Felson (1979), suggested that neighborhood level activities patterns influenced crime rates. They felt that the convergence in space and time of three elements—a motivated offender, a suitable target, and the absence of a capable guardian—resulted in increased likelihood of criminal events. In 1987, Felson furthered this theoretical position and found that types of land-use were related to increased crime, including the development of twelve typologies of land-use. Felson (1987) believed that by studying land-use, planners and managers could divert likely offenders from suitable targets. Also examining the effects of routine activities, but at the individual level, the Seattle victimization research suggests that ‘busy places’ bring greater neighborhood traffic and human density to an area (Rountree, Land, and Miethe, 1994).

In 1987, Stark offered a new theory of deviant places that combined ideas of social disorganization and routine activity theories. He suggested that ecological theories of crime try to explain why crime seems to be so heavily concentrated in certain areas, along the same lines

as the original social disorganization theorists' work. Stark (1987) believed that poor, dense neighborhoods tended to be mixed-use neighborhoods. He defined *mixed-use* as "urban areas where residential and commercial land use co-exist, where homes, apartments, retail shops, and even light industry are mixed together" (p. 898). Along the same theoretical lines, Stark believed that opportunity was an important key when discussing crime rates. His theory further suggested that mixed land-use increases the opportunities for deviance in three ways: by increasing familiarity with neighborhood, by offering increased opportunities, and by increasing the rates of congregation outside homes. Further, he felt that ecological explanations should be posed in terms that do not depend entirely, or even primarily, on compositional effects. This is the very idea that the early social disorganizationists were interested in -- avoiding 'kinds of people' explanations. Stark provided testable propositions in his ecological theory. One of which was that poor, dense, mixed-use neighborhoods with high transience rates tend to be dilapidated and have reduced levels community surveillance and more opportunities for deviance. Thus, these types of variables should be related to higher rates of crime.

Each of these three theoretical perspectives discusses the effects of ecology on neighborhood residents --- mostly in terms of the social ecology of the neighborhood with indirect approaches to the issues of physical ecology. The earliest works of the social disorganization perspective describe the differences in land-use patterns, by mentioning the qualitative finding that crime was heaviest in areas that were residential areas that shared use patterns with commerce and industry (Shaw and McKay, 1942). Routine activity theorists also approach the physical lay-out of neighborhoods indirectly by discussing it as the convergence in time and space of offenders, targets, and low guardianship. In his theory, Stark (1987) returns to the notion of mixed-use neighborhood patterns originally developed in social disorganization

theory. However while Stark mentions these ideas, they are not developed in terms of conceptualizing the definition and measurement standards that should be employed when studying deviant places.

### **CONCEPTUALIZING PHYSICAL ECOLOGY**

Thus regardless of one's ecological theory of choice, researchers are still faced with the question of how to conceptualize physical ecology -- how and what to measure -- when trying to examine the physical layout of a neighborhood. Traditionally in crime literature, physical ecology has been modeled and measured as types and counts of places (i.e., types of land use in an area) or as the amount of physical disorder (i.e., vandalism) in an area. Arguments have been made that land-use patterns or types of land-use affect crime through the type of land structure they represent or by increasing opportunities/offenders in an area. For example, Taylor and Harrell (1996) describe two forms of land-uses that may increase the number of people in a geographic area. First, neighborhood land-uses that may attract more individuals to an area are *movement generators*, such as roads. Second, other neighborhood land-uses are *attractors*, and they include both commercial and public-area land-uses. These categories are arguably related to those developed by the series of authors who have published the Seattle Victimization Study papers. This body of research examines the number of *busy places* as an indicator of social disorganization found on a block (Rountree, Land, and Miethe, 1994; Rountree and Land, 1996; Rountree, Wilcox, and Land, 1996). However, these same researchers consider the "flow of individuals" through an area (i.e., movement generators) as being relevant to the increased convergence of the potential offenders and opportunities. These researchers defined the busy places as schools, convenience stores, bars, fast food restaurants, office buildings, parks or playgrounds, shopping malls, hotels/motels, and bus stops.

Relative to *movement generators*, White (1990) found that neighborhood permeability, or the number of roads coming into an area, significantly influenced burglary rates. In addition, many researchers have found mass transit stops (e.g., bus stops, subway stops, etc.) are related to danger and crime (Block and Block, 2000; Block and Davis, 1996; Roncek, 2000) and have their highest effect in the blocks immediately surrounding the location (Block and Block, 2000).

Regarding *attractors*, at a basic interpretation of neighborhood land-uses, Taylor and Harrell (1996) found that the proportion of non-residential land-uses was related to higher burglary rates. Several commercial land-uses are related to increased crime rates. For example, Harrell and Gouvis (1994) found that the percentage of lots zoned for commercial was related to increased robbery rates. Duffala (1976) and Gordon and Brill (1996) demonstrated that convenience stores were related to increased crime rates. Gordon and Brill also suggested that shopping centers provided criminal opportunity. Many researchers have found that the presence of bars is related to higher rates of crime in the surrounding areas (Roncek and Maier 1991; Frisbie et al., 1978; Peterson, Krivo, and Harris, 2000). Publicly-used land can also influence crime rates. Sherman, Gartin, and Buerger (1989) suggested that parks might also be a hot spot for some crimes. Roncek (2000) found that public junior and senior high schools were related to higher amounts of robbery. Smith (1996) found that public parking facilities, and their environmental design, were related to increases in criminal activity. Several researchers have found that hospitals were related to higher crime rates (except murder and robbery) (Roncek and Fladung, 1983; Roncek and Franz, 1988; Smith, 1987). Even amongst residential types, there are differences. Several researchers have found that household-design characteristics were related to burglary risks (Brown, 1983; Molumby, 1976; Repetto, 1974; Waller and Okihiro, 1978). Apartment buildings are related to increased crime, especially if not adequately designed

(Gordon and Brill, 1996). Further, Fagan and Davies (2000) found that public housing increased the violent crime rates in the immediately surrounding areas. In support of this finding, Roncek (2000) found that public housing was related to higher amounts of robbery.

Although this type of research has produced a great deal of knowledge in the academic field, this type of methodological terminology (e.g., movement generators/attractors or busy places) is limited in its utility in non-academic applications. These terms are most useful at the individual level, when studying the journey to crime, or when theorizing about how and why offenders utilize some areas and not others. Arguably, this type of theoretical terminology could be replaced with more a more relevant typological standard. One such example of this is Felson's (1987) twelve typologies of land-use: public channels, storage nodes, residential, industrial, retail and trade, urban recreation, educational facilities, offices and public facilities, medical facilities, rustic recreation, rural industrial, and other. Public channels included streets, bus routes, and trains. Storage nodes included parking areas, airports, and bus depots. Urban recreation differed from rustic recreation, in that the prior included bowling, golf, and bars while the latter included parks and fairgrounds. Other land use included vacant land and unspecified buildings.

### **Areal Zoning**

However, the present paper applies a typology that is based on tax parcel assessment divisions and assignments of land-parcel structure/use. City and county offices regularly maintain tax assessment data on each land-parcel in their jurisdiction. These records are updated on a regular basis, and many policy decisions are based on these records. Further, these records are categorized and can be measured in research-based applications by city or county zoning practices. City zoning regulation bodies control the nature of land-use for each parcel, including

the size and type of structure that can be built on the land (Shlay and Rossi, 1981). The purposes of zoning regulations are to maintain levels of compatibility between neighboring land parcels, including the consideration of the residents in the surrounding areas (Novak and Seiler, 2001; Shlay and Rossi, 1981). In 1926, the Supreme Court supported this function of zoning laws in *Village of Euclid v. Amber Realty*, which allowed for the modification of zoning decisions in order to control land-use in a manner that promotes the “health and welfare of the general population of the community” (Novak and Seiler, 2001, p. 6). Schultz and Kasan (1984) outline a pyramidal land-use structure called Euclidian, or Cumulative, Zoning. This zoning system ranks strictly single-family residential land use as most desirable, single- and multi-family residential/commercial mixed land-use as the middle tier, and industrial and other heterogeneous land-use as the least desirable (Novak and Seiler, 2001; Schultz and Kasan, 1984). These rankings agree with the early social disorganizationists that generally find crime rates to be higher in neighborhoods that were near commercial and industrial zones.

### **Spot Zoning**

Beyond areal zoning practices, one zoning practice that can bring non-residential land-use into a residential only zone is called Spot Zoning. Novak and Seiler (2001) report that Spot Zoning can have consequences to residential neighborhoods and thus can place these neighborhoods further down the Euclidian pyramid. Novak and Seiler (2001) examined the effects of spot zoning on the amounts of observable physical disorder on residential neighborhoods. They found that the “mere existence of any commercial establishment in an otherwise residential social block is related to block level physical disorder” (p. 15). These research results supported other existing research that mixed land-use is related to physical disorder (Taylor, Koons, Kurtz, Green, and Perkins, 1995). Several social institutions, such as

convenience stores and bars have been found by some researchers to indeed be related to higher crime rates in the immediately surrounding neighborhoods (Harrell and Gouvis, 1994; Duffala, 1976; Gordon and Brill, 1996; Roncek and Maier 1991; Frisbie et al., 1978; Peterson, Krivo, and Harris, 2000).

### **Zoning Heterogeneity**

Other theorists and researchers have also suggested that crime patterns vary by the variations in land-use patterns—even at very low levels of spatial aggregation (Jacobs, 1961; Newman, 1972; Taylor and Gottfredson, 1986; Stark, 1987; Sherman, Gartin, and Buerger, 1989). That is, crime patterns within a neighborhood may be influenced by the physical ecology of that neighborhood, and changes in the neighborhood's physical ecological structure (i.e., spot zoning) may be related to increased/decreased crime rates within a neighborhood. For example, Taylor and Harrell (1996) believed that the “internal layouts, boundary characteristics, and traffic patterns of neighborhoods may encourage or discourage different types of crime” (p. 10). Further, changes in an area's land-use pattern have also influenced crime rates. Rengert and Wasilchick (1985) and Taylor and Harrell (1996) believed that changes in land-use patterns affected the exposure potential between offenders and that area's residents and users. The current research attempts to address the issues of spot zoning, through the identification of local institutions (i.e., convenience stores) as spot-zoned in the Bexar County Tax Appraisal database.

### **Interactions between Social and Physical Ecology**

In addition to the mere presence of a land-use type or an institution, theorists have also suggested that crime patterns may interact with social by the type of social environment (Jacobs, 1961; Newman, 1972; Taylor and Gottfredson, 1986; Stark, 1987; Sherman, Gartin, and Buerger, 1989). That is, institutions and land-uses may have different effects in neighborhoods with

different social ecologies. For example, as the numbers of bars increase and if they are found in deprived areas, they seem to have a larger effect of increasing rates of crime (Peterson, Krivo, and Harris, 2000). Other bodies of research have suggested that land-uses can be related to more positive outcomes in neighborhoods. Social disorganization and broken-windows theorists speculate about the influences of neighborhood disorder on the breakdown of neighborhood regulatory capabilities and institutions (Black, 1976; Kelling, 1998). For example, Kelling (1998) suggests that disorder, fear, and crime undermine the influence of social and economic institutions in an area, such as schools, churches, and commerce. As such, some institutions were traditionally considered to have positive influences on their surrounding neighborhoods. Peterson, Krivo, and Harris (2000) have examined the effects of some traditional neighborhood institutions. These researchers predicted that recreation centers, libraries, and economic institutions, such as banks and retail stores, might help reduce violent crime in communities. However, they only found the expected effect for recreation centers. Further, Peterson, et al. found that recreation centers reduced violent crime, such as robbery and rape, in severely disadvantaged areas.

As alluded to above, our research has four hypotheses. First, measures of social ecology will be related to crime rates. Second, measures of physical ecology will be related to increased crime rates, and may decrease the significance of some of the measures of social ecology. Third, this research measures whether social and physical ecological patterns interact to influence crime rates. And fourth, this research examines whether or not the level of aggregation influences the significance of results.

## METHODS

### **Data**

These hypotheses are evaluated for the city of San Antonio, Texas. San Antonio's population grew from 654,000 in 1970, to 785,880 in 1980 making it the 11th largest city in the United States. Since 1980, San Antonio continued growing to become the 9<sup>th</sup> largest city in the U.S., with a 1986 population estimated at 914,350. (Marlin, Avery, and Collins, 1980; Straub and Dupuis, 1988) Current data estimates the city population to be 1,171,700 in 1999 (San Antonio Police Department, 2001). The city has a diversified economy and has strong representation in the following employment types: agriculture, manufacturing, industrial, government (including several military institutions), health care, tourism, and high technology. In addition to its diversified economy, the city's population is also racially heterogeneous including a large Hispanic community. (Marlin, et al., 1980; Straub and Dupuis, 1988)

San Antonio, as with other large urban centers, also experiences a fairly substantial amount of crime. In 1999, SAPD received 787,946 dispatched calls for service. To accommodate city needs, SAPD employed 1,882 sworn officers and 505 full-time civilians. SAPD publishes the Uniform Crime Report statistics for Total Part I Crimes as 76,776, with a city crime rate of 65.6 in 1999 (SAPD, 2001). In addition to being a large urban center, San Antonio was selected because the Police Department publishes crime-events on the Internet, and identifies each crime event by the address of occurrence.<sup>1</sup>

This research employed a unique data set incorporating three types of information to examine the context of crime. Preliminary sources of data included census data; tax parcel data

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<sup>1</sup> SAPD does not publish the addresses for violent crimes that are either Sex offenses or offenses against children. In doing this, the department hopes to protect the privacy of these victims.

from Bexar County, Texas; and Violent Crime and Burglary crime-incident data from the San Antonio Police Department for the dates of August 1999 through August 2000. Locations of residential, commercial, and industrial areas were geocoded at the tax parcel level of aggregation. Both the tax parcel data and the crime-incident data were then aggregated to the blockgroup and census tract levels.

### **Dependent Variables**

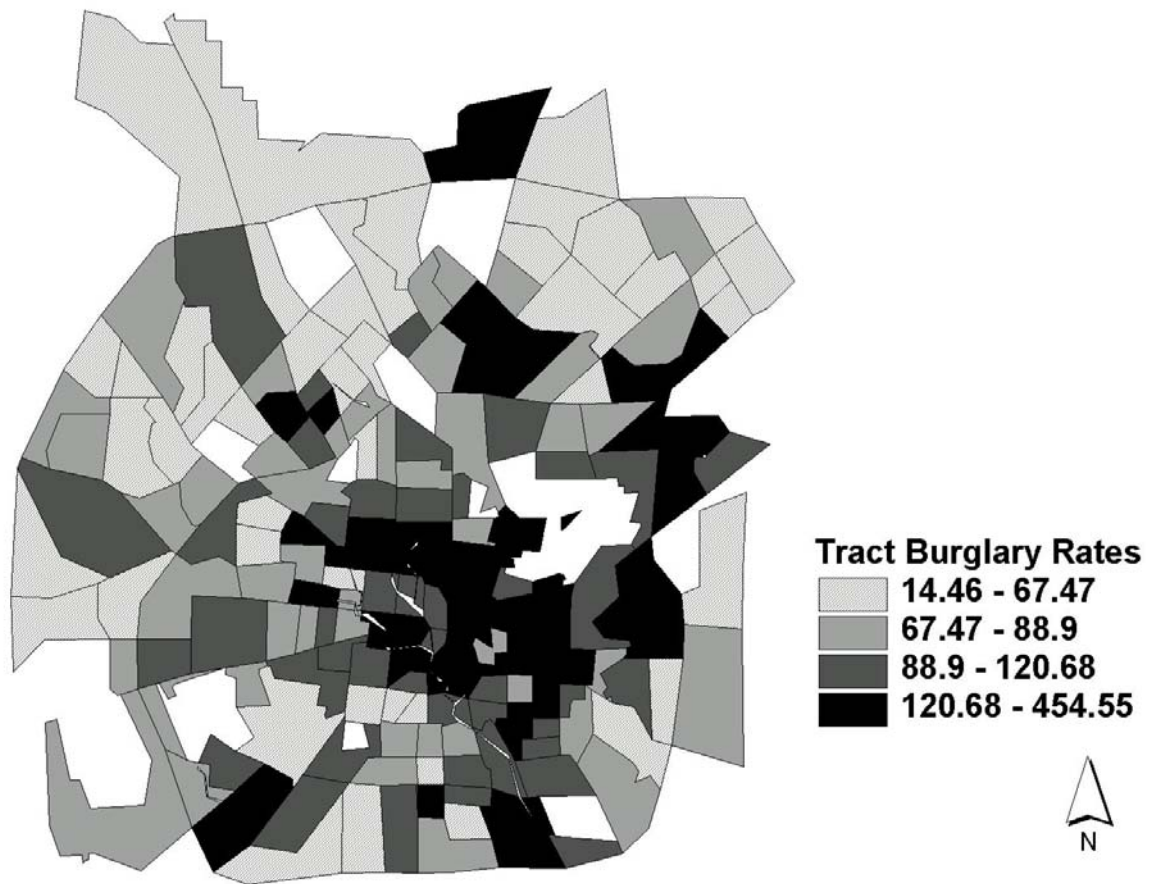
The crime-incident data was first address-matched to the 100-block using the GIS program Arcview 3.2a. Two dependent variables were investigated in this research, *burglary* and *violent crime*. The burglary measure included all attempted and completed burglaries of habitats and other buildings (N = 9,414). The violent crime measure included attempted and completed robberies, aggravated assaults, and murders (N = 2,516). Address matching was performed interactively, and final matching rates varied by police precinct ranging from 82-97%.<sup>2</sup> Violent incidents were matched at an 85% success rate, and burglaries were matched at an 89% success rate. Because the published addresses do not provide additional information to which a location could be attached, the rates were unable to be further improved. Individual events were aggregated to the blockgroup and census tract levels as rates per 1,000 residents. Incidents that did not provide a 100-block street address were not used in the address-matching procedure. Thus, we did not include offenses such as rape in our measure of violent crime rates. These events could not have been address-matched to the correct sides of the streets and then would not have been able to be assigned to the appropriate census tract or blockgroup (if these events fell along roads that were on such boundaries). (See Figures 1 through 4 for illustrations

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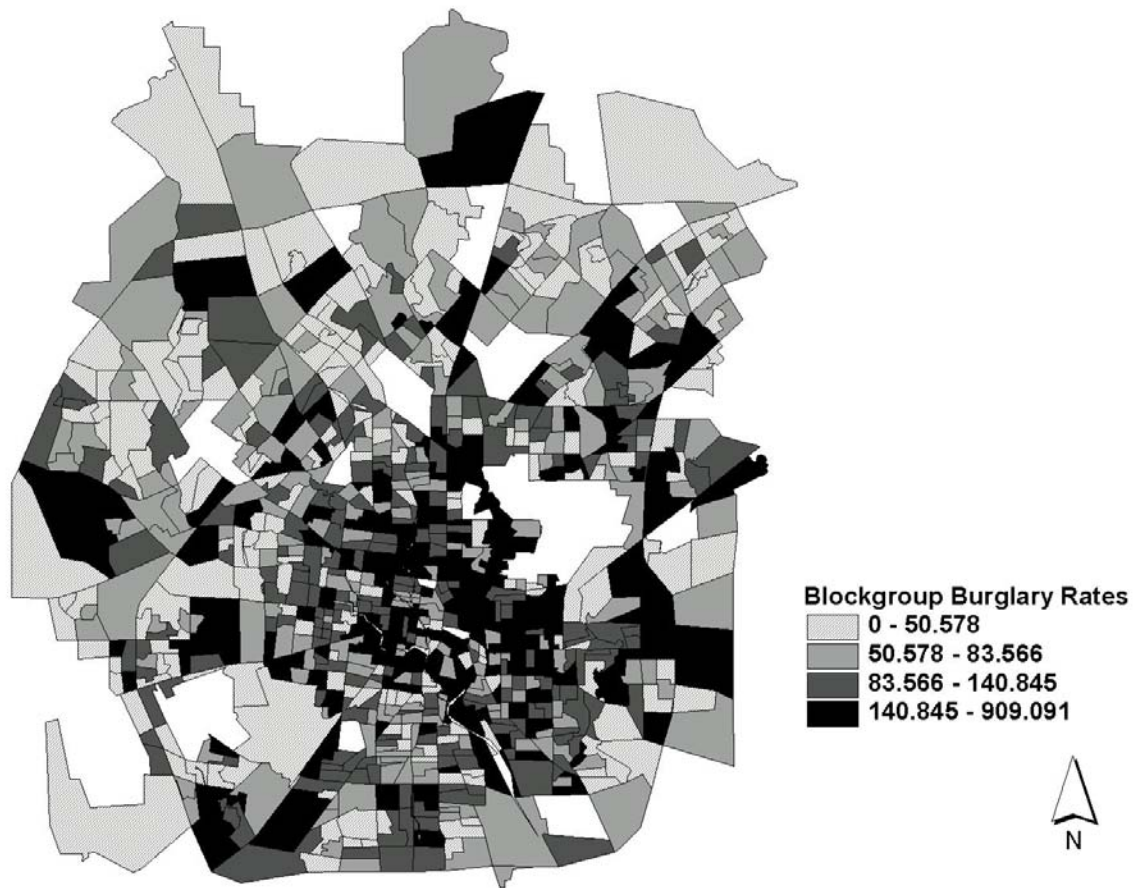
<sup>2</sup> The unmatched addresses were not significantly correlated to either the district of origin or to the crime type that was reported ( $p > .05$ ).

of burglary and violent crime rates, each with the tract-level map displayed first.)

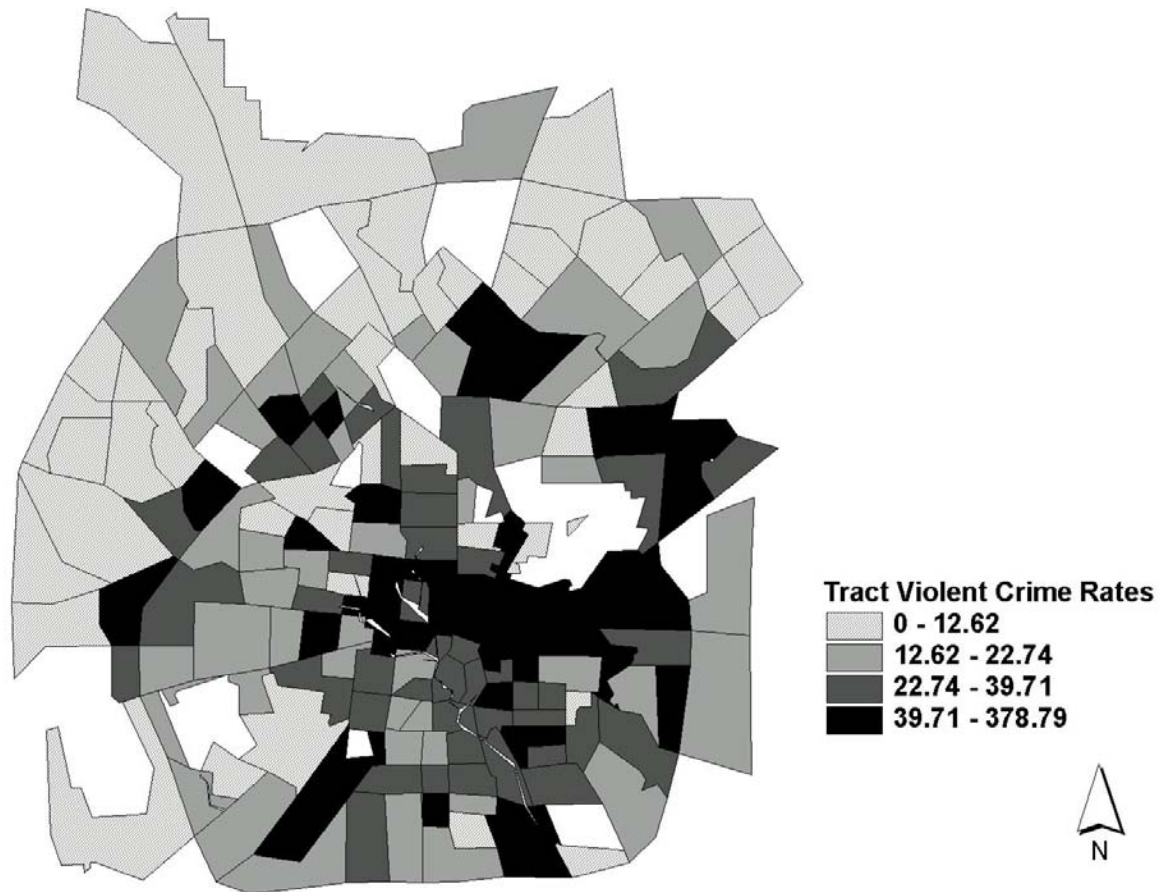
**Figure 1: Burglary Crime Rates at the Tract-Level**



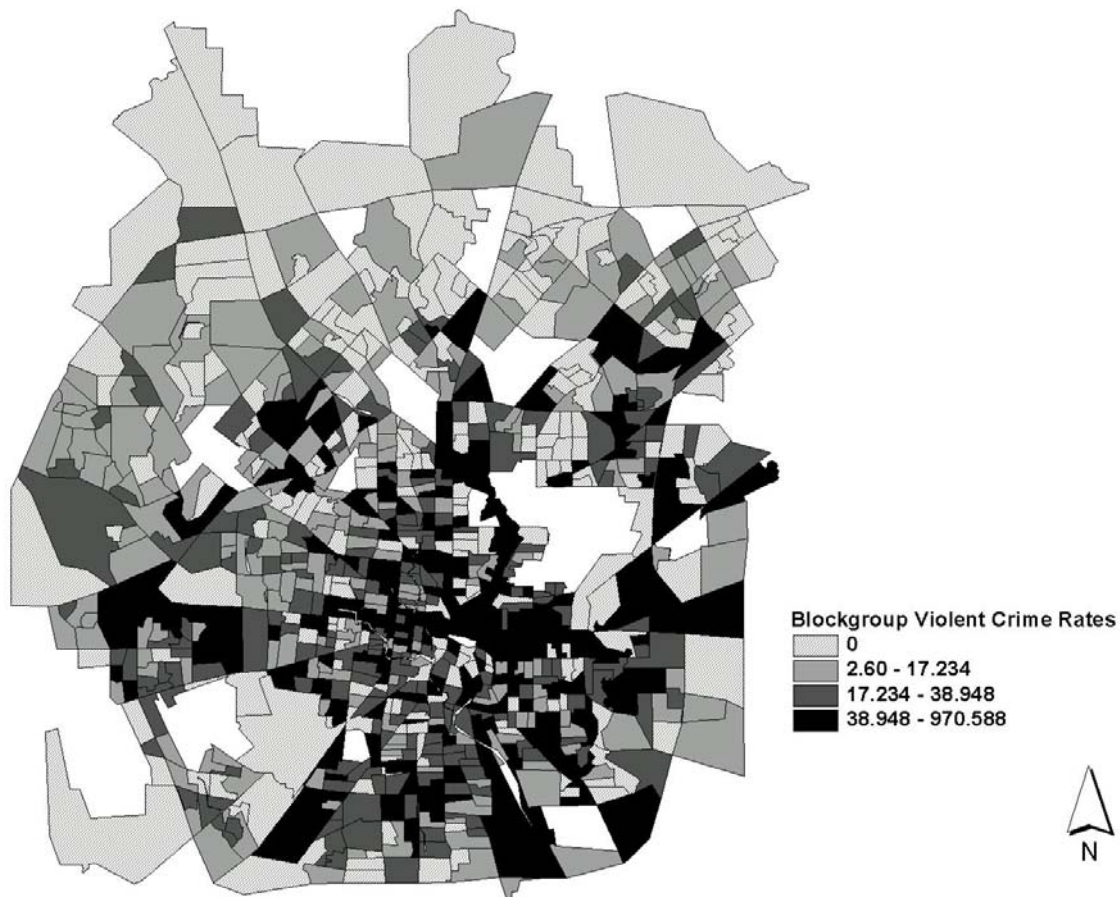
**Figure 2: Burglary Crime Rates at the Blockgroup-Level**



**Figure 3: Violent Crime Rates at the Tract-Level**



**Figure 4: Violent Crime Rates at the Blockgroup-Level**



### **Social Dynamics and Characteristics**

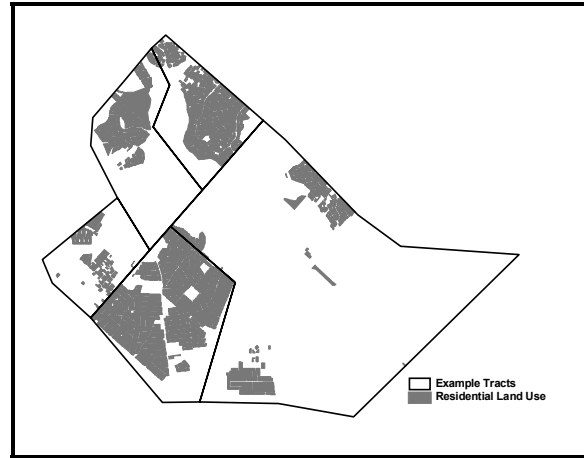
The current research uses two scales to describe social structure, created from 1990 census variables (Morenoff and Sampson 1997; Sampson, Raudenbush, and Earls 1997; Sampson, Morenoff, and Earls 1999). First, a *concentrated economic disadvantage* scale describes the relative conditions poverty stricken neighborhoods. This scale is defined as percent of individuals below the poverty line, percent receiving public assistance, percent unemployed, and percent of households that are female-headed with children. Second, *concentrated immigration* is defined by the percent of persons foreign born, the percent linguistically isolated, and the percent Hispanic. Following the precedent of Sampson et al. (1997, 1999) the above

variables were processed using factor analysis. Regardless of the rotation method used in the formation of the scales, each scale loaded on single factors using either principal components or alpha-scoring factor analysis. In addition, both social disorganization and routine activity theory research suggests that neighborhood instability is also conceptually important. Thus, we employ an *index of residential instability* mobility and percent renters in our analytical models. This index is created by calculating the z-scores for the census measures of residential mobility and percent renters. These z-scores are summed and then divided by two (Sampson et al., 1997, 1999). *Population density* is defined as the number of persons per square kilometer. Rather than relying on the physical area of land within the blockgroup or tract, area is calculated *after* subtracting out commercial parcels, industrial parcels, parks and vacant lots, which are obviously not intended for residential use. This definition is different than traditional measures of population density, as it strictly refers to the number of people in the land-use available for residential purposes. The correlation between traditional density measures and the measure used in this paper was only .33. Figure 5 illustrates the difference between traditional blockgroup size and residential land only, while Figure 6 illustrates this same difference only between tract size and residential lands.

**Figure 5: Census Blockgroup Areas and Residential Land Use Patterns**



**Figure 2: Census Tract Areas and Residential Land Use Patterns**



Finally, we also control for the *percent male* in the population and the *percent of the population between the ages of 18 and 24*.

### **Measures of Physical Ecology**

Several indices of urban physical ecology are also used. First, following early social disorganization theory *distance from central city* is defined as the distance between the centroid of the central downtown tract and the centroids of all other tracts in the San Antonio area.<sup>3</sup> Second, as noted above, locations of residential, commercial, and industrial areas were included in the tax parcel data. As land-use patterns are dictated by city/county zoning regulation bodies, the current research suggests that physical ecology should be based on the divisions of land-use that are already established by the Bexar County Tax Appraiser's Office. Each land parcel is zoned Land that is designated for a specific land-use (e.g., single-residential, industrial, etc.) is being used as that designated land use. As these databases are constantly being edited when spot-zoning changes are made, we feel that this type of terminology is more appropriate and

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<sup>3</sup> These distances were calculated using the Arcview Extension entitled "Nearest Feature with Distances and Bearings (v.3)" (Jenness, 2000).

useful than terminology created by researchers. Beyond the practicality of this suggestion, this type of research lends itself to policy and applied work thus basing land-use identification by the agency responsible for such decisions may make it easier to assess policy decisions about land-use and crime by city governments, appraisal offices, and police departments.

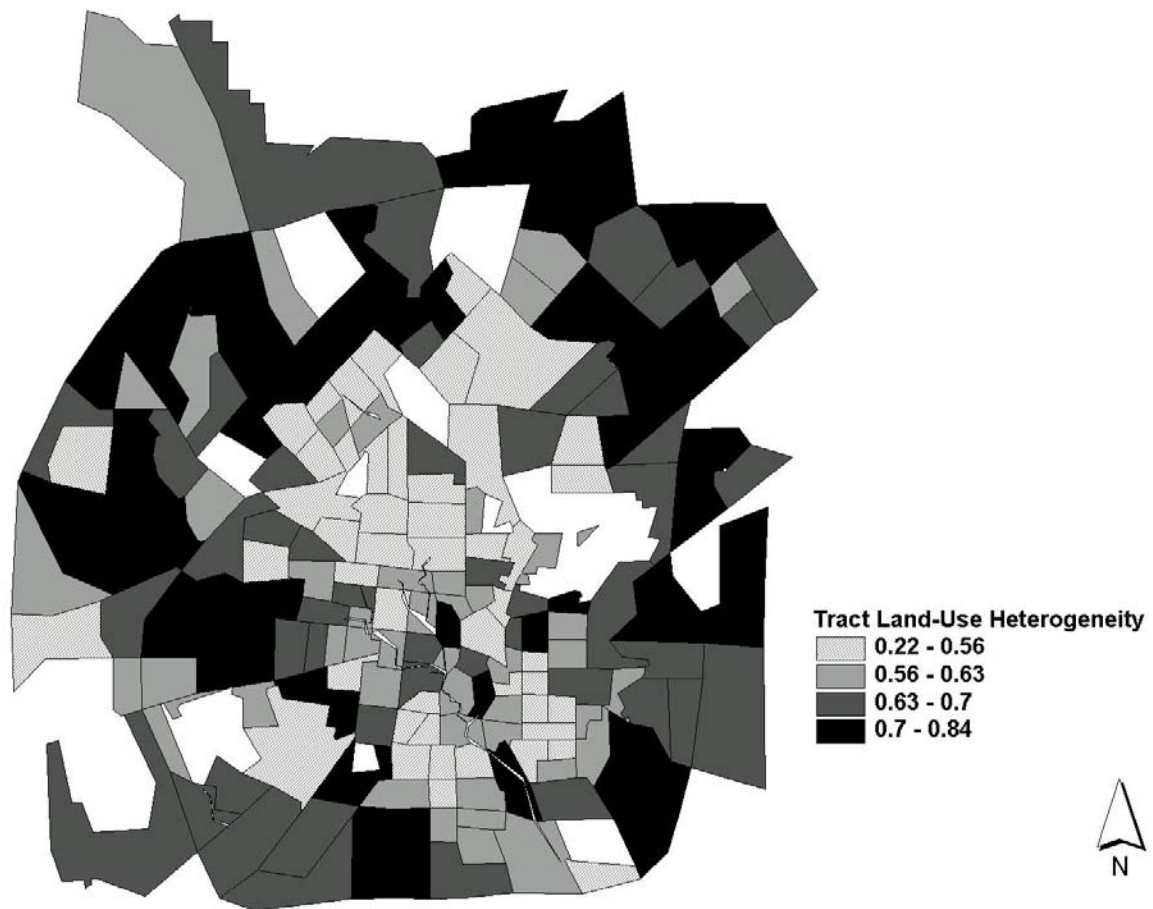
The measures of physical ecology that come from this data are represented in two forms, as an *index of zoning diversity* and as well as separate land-use types when deemed as theoretically important. To calculate an index of land-use heterogeneity, this research employs a form of the entropy index. The entropy index, also called the Shannon index, is a measure of relative diversity and it “describes both the richness or variety of subpopulations and the equality or evenness of their sizes” (Allen and Turner, 1989, p.525). This index will be used to rank blockgroups and census tracts according to the value. The entropy index is at its highest value when all types of land-use are equally represented in the census tract, and the index is zero when only one type of land use is in the tract. (White, 1986; Allen and Turner, 1989) The index is calculated as follows:

$$\text{Entropy Index (H)} = - \sum_{k=1}^k P_k \log P_k$$

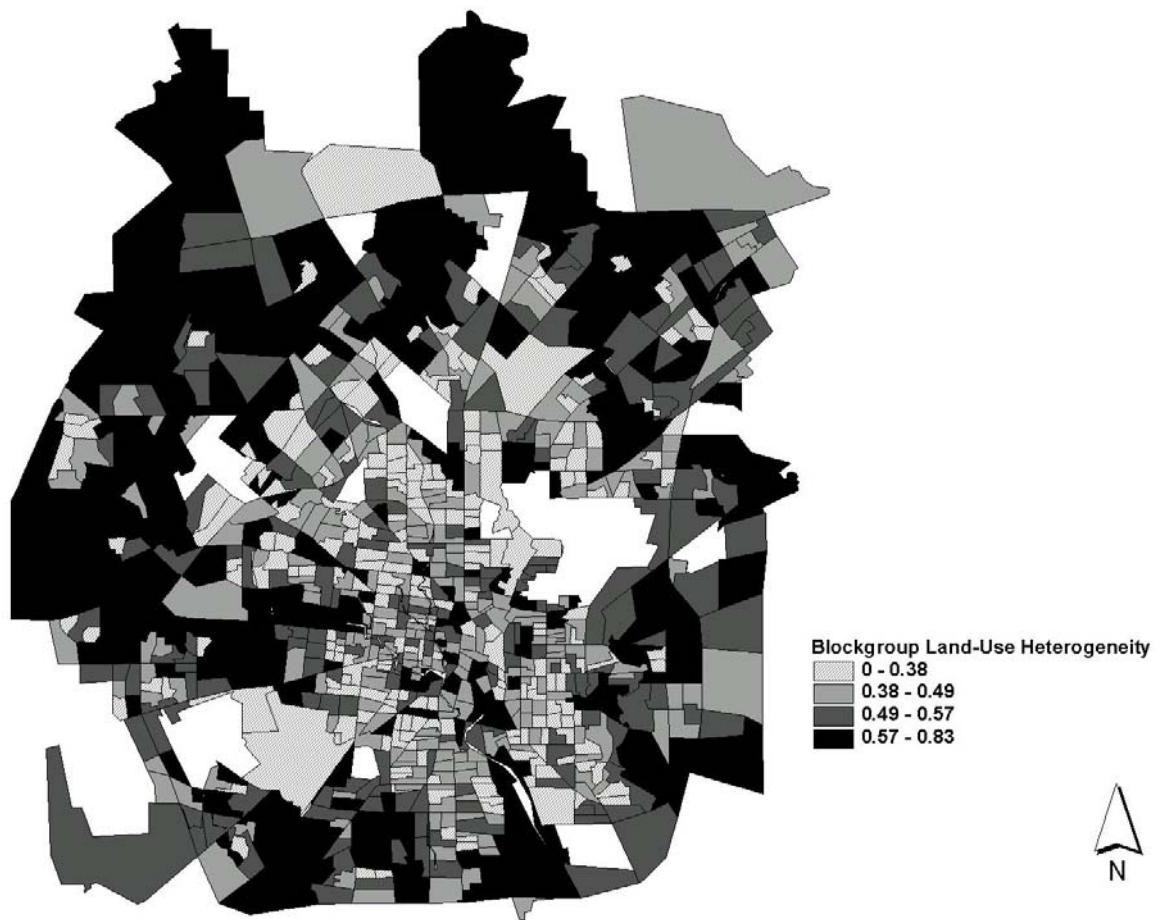
where  $P_k = N_k/N$ ,  $N_k$  = number of parcels in the kth group, and  $N$  = sum of all parcels in the area (i.e., blockgroup or census tract) being measured. This index measures the heterogeneity of zoning practices within blockgroups and tracts. This research examines nine zoned land-use types: single residential, multiple-family residential (both those zoned as residential and those zoned as commercial multi-family parcels), industrial, commercial, permanent value (publicly owned property), exempt (churches, charitable organizations, veteran’s associations, etc.), vacant (residential and commercially zoned areas), agricultural (commercial and farm properties), other

(railroad, utility, auxiliary). See Figures 7 and 8 for illustrations of land-use heterogeneity for census tracts and blockgroups respectively.

**Figure 7: Land Use Heterogeneity at the Tract-Level**



**Figure 8: Land Use Heterogeneity at the Blockgroup-Level**



In addition to examining zoning diversity and individual land-use types, the current research draws on past findings suggesting that several institutions (i.e., spot zoning) present significant theoretical significance as individual parcels. The following institutions were determined to represent crime attractors: bars, hotels/motels, convenience stores, restaurants, fast food restaurants, shopping centers, parking garages, schools, and hospitals. Other institutions were determined to represent traditional institutions that may decrease crime: recreation centers and banks. These presence or absence of each of these institution types were aggregated both to the blockgroup and tract levels.

## **Analysis**

The descriptive statistics associated with the dependent and independent variables in the analyses are presented in Table 1. In order to examine how land-uses co-varied within

***[TABLE 1 ABOUT HERE]***

neighborhoods, the current research next examined the correlations between land-use variables.

The correlations between the *Index of Mixed Land-Use* and other forms of land use indicate that neighborhoods with higher percentages of single family residences are negatively correlated with mixed-use patterns, while positively correlated (albeit moderately) with multiple family, industrial, commercial, and vacant land uses (See Tables 2 and 3 for correlations at the tract and blockgroup levels respectively).

***[TABLES 2 AND 3 ABOUT HERE]***

The data are first analyzed using traditional Ordinary Least Squares regression. However, the very nature of the data being analyzed is spatial, and such data often violates the “requirements of independence and homogeneity required in classical statistics” (Anselin, 1998, p.5). Geographically referenced data is often linked by locational similarity and value similarity, a condition known as spatial autocorrelation (Anselin, 1988; 1990; 1992; 1998; Morenoff, Sampson, and Raudenbush, 2001; Baller, Anselin, Messner, aDean, and Hawkins, 2001). Diagnostic tests indicated that these analyses required the use of spatial lag models.<sup>4</sup> Anselin

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<sup>4</sup> Diagnostic tests were performed to determine the nature of the problem caused by the spatial dependence—was it a nuisance, meaning that one needs to increase sample size or incorporate the spatial autocorrelation in a regression error term, or was it substantive, meaning that the structure of the spatial dependence needs to be incorporated as an explanatory variable in the model (Anselin, 1988; 1990; 1992; 1998).

(1992) illustrated the spatial autoregressive model to be specified as follows, with a spatially lagged dependent variable term as one of the explanatory variables:

$$Y = DW_y X\beta + \varepsilon$$

“where  $y$  is a  $N$  by  $1$  vector of observations on the dependent variable,  $W_y$  is a  $N$  by  $1$  vector of spatial lags of the dependent variable,  $D$  is a spatial autoregressive coefficient,  $X$  is a  $N$  by  $K$  matrix of observations on the (exogenous) explanatory variables with associated a  $K$  by  $1$  vector of regression coefficients  $\beta$ , and  $\varepsilon$  is a  $N$  by  $1$  vector of normally distributed random error terms, with means  $0$  and constance (homoskedastic variances  $\sigma^2$ .” (p.188-189). When the autoregressive parameter is known, the model then becomes:

$$y - \beta W_y = X\beta + \varepsilon$$

If a normal error assumption can be made then a full maximum likelihood estimation process will be performed (Anselin, 1992). Anselin (1992) noted that the consequence for ignoring dependence amongst the errors using geographic data is that the OLS estimates will be biased and inferences based on an SAR Model will be incorrect. In addition, he suggests that failure to include the  $W_y$  coefficient would be similar to the failure to include a significant explanatory variable in the model.

## **RESEARCH FINDINGS**

Variables were entered progressively across 3 models. The first model introduced census specific variables and indices created from census measures. The second model introduces the GIS derived contextual variables. Finally, the third model introduced two final variables. These were interaction terms between the index of land-use heterogeneity and the neighborhood's levels of instability and population density.

### **Tract-Level Results**

At the tract level, the full SAR Model (SAR Model 3 in Table 4) suggested that the census variables related to decreased burglary rates were the percent of tract residents between the ages of 18-24 and the percent of residents that were male. Further, increased distance from the center of San Antonio was related to decreased burglary rates. Population density was related to increased burglary rates. The percent of land that was used for single-family residential purposes was related to decreased burglary crime rates. Further, higher burglary crime rates were more likely to be found in more homogeneous land-use tracts land with smaller populations. (See Table 5)

***[TABLE 4 ABOUT HERE]***

The full SAR Model for violent crime rates (Model 3 in Table 5) suggests that at the tract level, the only census variable that was related to decreased rates was the percent of tract residents between the ages of 18-24. Further, increased distance from the center of San Antonio was related to decreased rates of reported violence. Population density was related to increased violent crime rates. The percent of land that was used for both single and multiple family residential purposes was related to decreased violent crime rates. As was found for burglary rates, higher violent crime rates were more likely to be found in more homogeneous land-use tracts land with smaller populations. (See Table 5)

***[TABLE 5 ABOUT HERE]***

### **Blockgroup-Level Results**

At the blockgroup level, the full SAR Model (SAR Model 3 in Table 6) concentrated immigration was related to lower burglary rates. Further, residential instability was related to increased burglary rates. Of the physical ecology variables, the distance from downtown was

related to decreased burglary rates. Several of the physical ecology variables were related to increased crime rates, including the percent of land zoned for commercial purposes, the percent of vacant land, as well as increased numbers of convenience stores, hospitals, and stores. Finally, the significant interaction between land-use heterogeneity and population density suggests that higher burglary crime rates were more likely to be found in more heterogeneous land-use blockgroups with larger populations.

At the blockgroup level both significance levels of coefficients are altered. At the blockgroup level, the percent land zoned for multiple-family residential purposes and the percent male are no longer significant. In addition, concentrated immigration is related to lower burglary crime rates, but the percent of land used for commercial purposes as well as the presence of convenience stores and stores are related to higher burglary rates. (See Table 6)

***[TABLE 6 ABOUT HERE]***

The spatial lag model for violent crime rates (Model 3 in Table 7) suggest that at the blockgroup level, the only concentrated immigration was related to lower rates. Further, increased distance from the center of San Antonio was related to decreased rates of reported violence. Population density was related to increased violent crime rates. The percent of land that was used for single-family residential purposes was related to decreased violent crime rates. Higher violent crime rates were more likely to be found in more heterogeneous land-use tracts land with larger populations.

However, as found in the comparison between regressions performed at the tract level and those run at the blockgroup level for burglary rates, for the violent crime rates the blockgroup level significance levels of coefficients are altered. At the blockgroup level, the percent between the ages of 18 and 24, the percent male, population density, and the percent of

land occupied by multiple-family residences are no longer significant. In addition, concentrated immigration and the index of mixed land-use are related to lower burglary crime rates, but the percent of land used for commercial purposes; and the presence of convenience stores/gas stations and stores are related to higher violence rates. (See Table 7)

***[TABLE 7 ABOUT HERE]***

**CONCLUSION**

The purpose of this paper has been to define and identify relevant land-use patterns that influence property and violent crime rates, while simultaneously examine how the influence of patterns change with increasing definitions of neighborhood size. This project has used calls-for-service data from the San Antonio Police Department, tax parcel data, and census data and found that land-use patterns were related to both burglary and violent crime rate patterns.

First, this research explored how and to what degree physical ecological patterns vary within neighborhoods. Patterns varied significantly, including the percentage of land use dedicated to residential, industrial, commercial, and other uses. Second, this project examined whether these measures of physical ecology and neighborhood use have an impact on crime. Several variables seemed to consistently influence crime rates, these included GIS derived variables and measures of physical ecology. As the distance from the central city increased both types of crime rates appeared to be lower. The index of land use heterogeneity was an important predictor of violent crime rates at both the blockgroup and tract levels. The presence of higher percentages of land-use dedicated to single family residences was related to lower rates of violent crime at both the blockgroup and tract levels, and higher rates of burglary and the census tract level. At the blockgroup level, increased percentages of land used for industry was related to increased burglary and violent crime rates, while the percentage of land used for commerce

was related to increased violent crime rates. Further, several local institutions were found to be related to crime rates at the blockgroup level. These institutions included: convenience stores/gas stations, hospitals, hotels, and stores. These findings are consistent with social disorganization theory, as written by Shaw and McKay (1942) and with Stark's (1987) conception of land-use patterns.

Third, this research measured the effects of neighborhood-level social ecology on crime rates. At the blockgroup level, concentrated immigration was related to lower rates of both burglary and violence. Residential instability was related to higher burglary rates, while a higher percentage of individuals between the ages of 18-24 was related to lower rates of reported violence. At the tract level, the percent male was related to lower burglary rates, while residential instability was related to higher rates of tract violence. Economic disadvantage was related to increased violent crime rates at the tract level.

Fourth, this work explored whether or not the physical ecological patterns interacted with neighborhood-level measures of social activity patterns to influence crime rates. In heterogeneous land-use blockgroups with higher populations, both types of crime rates were higher. Further, heterogeneous land-use tracts with a lot of residential mobility showed a lower relationship to violent crime rates at the tract level.

Fifth, this research examined whether or not the level of aggregation influenced the significance of results. These differences that are evident when directly comparing crime rates at the tract level with those at the blockgroup level are very important, as there are several effects at the blockgroup level that tract-based only research studies may be missing. The effects of structure somewhat washed out when block-groups were aggregated up to the census-tract level. While industrial, commercial, and vacant land-uses played roles at the blockgroup levels, they

were insignificant variables at the tract level. Further, of the institutional variables, only hospitals remains significant at the tract level. The effects of all other institutions, such as convenience stores, hospitals, hotels, and stores appears to disappear at the tract level. Thus, the level of aggregation is very important in determining which structural variables are important across levels. Future research should consider their level of aggregation in relationship to the types of variables that they are examining. Additional findings of this research regarded the use of the proper method of statistical analysis. This diagnostic tests indicated that the analyses for this paper required the use of spatial lag models. These models produced estimates that were more efficient than OLS, and several variables emerged as significant in the spatial lag models that were not significant in the traditional models.

Indeed, land-use patterns are important when studying neighborhood crime rates, and criminologists now have access to better data and methodologies to use when studying social phenomena, like crime rate patterns, in neighborhoods. Criminologists must no longer give primacy to social characteristics in their research. Social characteristics of neighborhoods remain accessible through census and survey measures, and now measures of physical ecology are becoming easier to define and measure. The physical ecology of a neighborhood is the composite of many structural characteristics. This research project combines unique methodology identifies several theoretically and empirically relevant land-use patterns that influence property and violent crime rates. Further, the empirical results demonstrate how the influence of patterns change with increasing definitions of neighborhood size.

